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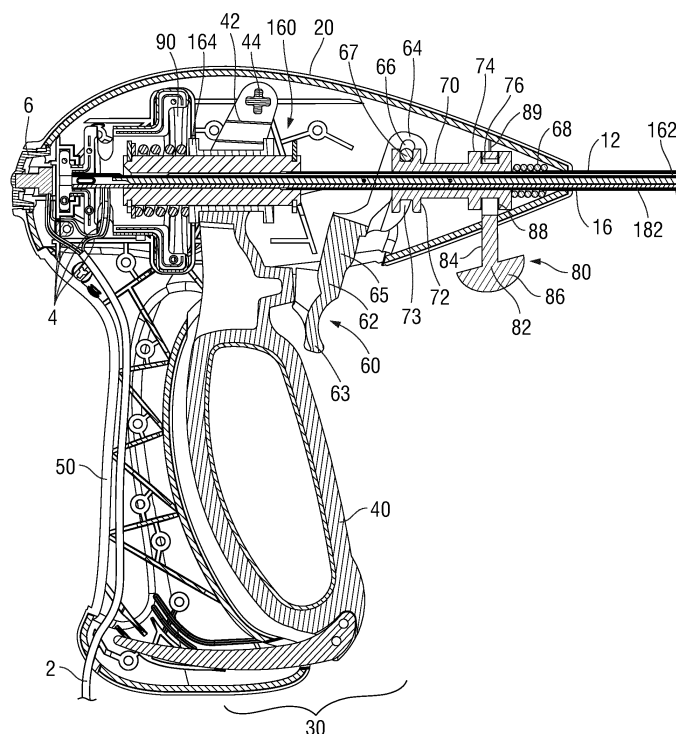
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(54) SURGICAL FORCEPS WITH SCALPEL FUNCTIONALITY

(57) A surgical forceps includes a knife bar having a knife translatable between a retracted position, a first extended position, and a second extended position. A trigger is operably coupled with the knife bar such that movement of the trigger between an un-actuated position, a first actuated position, and a second actuated position correspondingly moves the knife. An actuator is movable between locked and unlocked positions such that: with the trigger in the un-actuated or first actuated position and the actuator in the locked position, movement of the trigger to the second actuated position is inhibited; with the trigger in the second actuated position and the actuator in the locked position, the trigger is retained in the second actuated position; and with the actuator in the unlocked position, the trigger is movable between the un-actuated or first actuated position and the second actuated position.

**FIG. 5A****EP 3 072 467 A1**

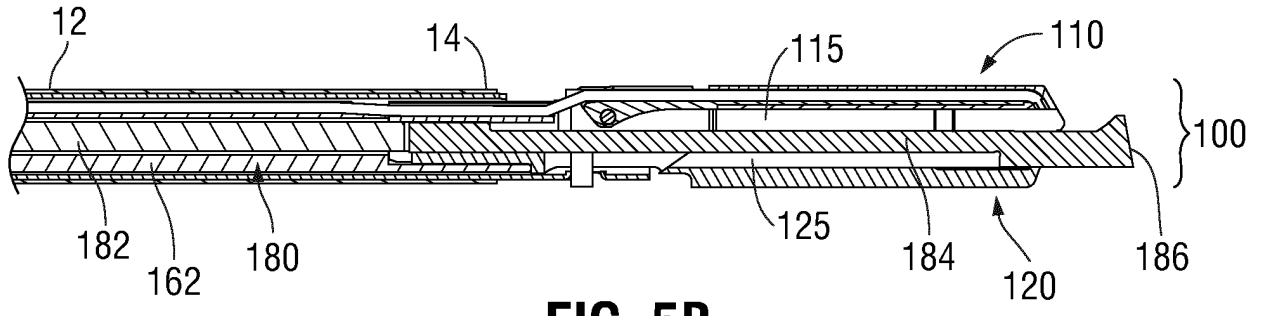


FIG. 5B

Description

BACKGROUND

Technical Field

[0001] The present disclosure relates to surgical instruments and, more particularly, to surgical forceps for grasping and/or treating tissue that incorporates a retractable knife capable of being used as a scalpel.

Background of Related Art

[0002] A forceps is a plier-like instrument which relies on mechanical action between its jaws to grasp, clamp and constrict tissue. Electrosurgical forceps utilize both mechanical clamping action and electrical energy to affect hemostasis by heating tissue to treat, e.g., coagulate, cauterize, and/or seal, tissue. Typically, once tissue is treated, the surgeon has to accurately sever the treated tissue. Accordingly, electrosurgical forceps have been designed which incorporate a knife or blade member which effectively severs the tissue after electrosurgical treatment thereof.

[0003] In some surgical procedures, it is necessary to dissect through one or more layers of tissue, for example, in order to reach underlying tissue(s) to be treated and/or divided. As can be appreciated, it may be beneficial, particularly with respect to endoscopic surgical procedures, to provide a single instrument capable of performing both of these tasks, thereby obviating the need to alternately remove and insert different instruments in favor of one another.

SUMMARY

[0004] As used herein, the term "distal" refers to the portion of the instrument or component thereof that is being described which is further from a user, while the term "proximal" refers to the portion of the instrument or component thereof that is being described which is closer to a user. Further, to the extent consistent, any of the aspects disclosed herein may be used in conjunction with any or all of the other aspects disclosed herein.

[0005] In accordance with aspects of the present disclosure, a surgical forceps is provided including a housing, a shaft extending distally from the housing, an end effector assembly disposed at a distal end of the shaft and including first and second jaw members configured for grasping tissue therebetween, a knife assembly, a trigger assembly, and a knife lock assembly. The knife assembly is disposed within the shaft and includes a knife bar having a knife disposed at a distal end thereof. The knife bar is longitudinally translatable through the shaft and relative to the end effector assembly to translate the knife between a retracted position, wherein the knife is disposed proximally of the end effector assembly, a first extended position, wherein the knife extends between

the first and second jaw members, and a second extended position, wherein the knife extends distally from the first and second jaw members. The trigger assembly is associated with the housing and includes a trigger operably coupled with the knife bar such that movement of the trigger between an un-actuated position, a first actuated position, and a second actuated position moves the knife between the retracted position, the first extended position, and the second extended position, respectively. The knife lock assembly is associated with the housing and includes an actuator movable between a locked position and an unlocked position. With the trigger disposed in the un-actuated position or the first actuated position and the actuator disposed in the locked position, movement of the trigger to the second actuated position is inhibited. With the trigger disposed in the second actuated position and the actuator disposed in the locked position, the trigger is retained in the second actuated position. With actuator disposed in the unlocked position, the trigger is movable between the un-actuated position or the first actuated position and the second actuated position.

[0006] In an aspect of the present disclosure, the trigger assembly includes a slider coupled between the trigger and the knife bar. In such aspects, with the trigger disposed in the un-actuated position or the first actuated position and the actuator disposed in the locked position, the actuator interferes with the slider to inhibit movement of the trigger to the second actuated position; with the trigger disposed in the second actuated position and the actuator disposed in the locked position, the actuator engages the slider to inhibit movement of the slider, thereby retaining the trigger in the second actuated position; and with actuator disposed in the unlocked position, the actuator permits translation of the slider therethrough such that the trigger is movable between the un-actuated position or the first actuated position and the second actuated position.

[0007] In another aspect of the present disclosure, the slider includes a proximal mandrel operably coupling the trigger with the knife bar and a distal mandrel operably associated with the actuator.

[0008] In yet another aspect of the present disclosure, the actuator is biased towards the locked position.

[0009] In still another aspect of the present disclosure, the actuator includes an actuator button disposed on the housing. The actuator button is selectively depressible relative to the housing to move the actuator from the locked position to the unlocked position.

[0010] In still yet another aspect of the present disclosure, the forceps further includes a drive assembly including a drive bar slidably disposed within the shaft. The drive bar is coupled to at least one of the first and second jaw members at a distal end thereof. The forceps, in such aspects, further includes a handle assembly associated with the housing and including a movable handle operably coupled with the drive bar. The movable handle is movable between an initial position and a compressed

position for moving the first and second jaw members from a spaced-apart position to an approximated position for grasping tissue therebetween.

[0011] In another aspect of the present disclosure, each of the first and second jaw members includes an electrically-conductive surface adapted to connect to a source of energy for treating tissue grasped between the first and second jaw members.

[0012] In still another aspect of the present disclosure, each of the first and second jaw members defines a knife slot configured to permit reciprocation of the knife there-through.

[0013] Another surgical forceps provided in accordance with aspects of the present disclosure includes a housing, a shaft extending distally from the housing, an end effector assembly disposed at a distal end of the shaft and including first and second jaw members configured for grasping tissue therebetween, a knife assembly, a slider, a trigger assembly, and a knife lock assembly. The knife assembly is disposed within the shaft and includes a knife bar having a knife disposed at a distal end thereof. The knife bar is longitudinally translatable through the shaft and relative to the end effector assembly to translate the knife between a retracted position, wherein the knife is disposed proximally of the end effector assembly, a first extended position, wherein the knife extends between the first and second jaw members, and a second extended position, wherein the knife extends distally from the first and second jaw members. The slider is operably coupled to the knife bar. The trigger assembly is associated with the housing and includes a trigger operably coupled with the slider such that movement of the trigger between an un-actuated position, a first actuated position, and a second actuated position moves the knife between the retracted position, the first extended position, and the second extended position, respectively. The knife lock assembly is associated with the housing and includes an actuator movable between a locked position and an unlocked position. In the locked position, the actuator interferes with the slider to inhibit movement of the trigger from the un-actuated position or the first actuated position to the second actuated position. In the unlocked position, the actuator permits movement of the trigger between the un-actuated position or the first actuated position and the second actuated position.

[0014] In an aspect of the present disclosure, the slider includes a proximal mandrel operably coupling the trigger with the knife bar and a distal mandrel operably associated with the actuator.

[0015] In another aspect of the present disclosure, the actuator is biased towards the locked position.

[0016] In still another aspect of the present disclosure, the actuator includes an actuator button disposed on the housing. The actuator button is selectively depressible relative to the housing to move the actuator from the locked position to the unlocked position.

[0017] In yet another aspect of the present disclosure, a drive assembly including a drive bar slidably disposed

within the shaft is provided with the surgical forceps. The drive bar is coupled to at least one of the first and second jaw members at a distal end thereof. In such aspects, a handle assembly associated with the housing and including a movable handle operably coupled with the drive bar is also provided. The movable handle is movable between an initial position and a compressed position for moving the first and second jaw members from a spaced-apart position to an approximated position for grasping tissue therebetween.

[0018] In still yet another aspect of the present disclosure, each of the first and second jaw members includes an electrically-conductive surface adapted to connect to a source of energy for treating tissue grasped between the first and second jaw members.

[0019] In another aspect of the present disclosure, each of the first and second jaw members defines a knife slot configured to permit reciprocation of the knife there-through.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Various aspects of the present disclosure are described herein with reference to the drawings wherein like reference numerals identify similar or identical elements:

FIG. 1A is a side, perspective view of an endoscopic surgical forceps provided in accordance with the present disclosure;

FIG. 1B is an enlarged, side, perspective view of the distal end of the forceps of FIG. 1 A;

FIG. 2A is a side, cross-sectional view of the proximal end of the forceps of FIG. 1A, wherein the movable handle is disposed in an initial position and the trigger is disposed in an un-actuated position;

FIG. 2B is a side, cross-sectional view of the distal end of the forceps of FIG. 1A, wherein jaw members of the end effector assembly are disposed in a spaced-apart position corresponding to the initial position of the movable handle and wherein a knife is disposed in a retracted position corresponding to the un-actuated position of the trigger;

FIG. 3A is a side, cross-sectional view of the proximal end of the forceps of FIG. 1A, wherein the movable handle is disposed in a depressed position and the trigger is disposed in the un-actuated position;

FIG. 3B is a side, cross-sectional view of the distal end of the forceps of FIG. 1A, wherein the jaw members of the end effector assembly are disposed in an approximated position corresponding to the depressed position of the movable handle and wherein the knife is disposed in a retracted position corre-

sponding to the un-actuated position of the trigger;

FIG. 4A is a side, cross-sectional view of the proximal end of the forceps of FIG. 1A, wherein the movable handle is disposed in an depressed position and the trigger is disposed in a first actuated position;

FIG. 4B is a side, cross-sectional view of the distal end of the forceps of FIG. 1A, wherein the jaw members of the end effector assembly are disposed in the approximated position corresponding to the depressed position of the movable handle and the knife is disposed in a first extended position corresponding to the first actuated position of the trigger;

FIG. 5A is a side, cross-sectional view of the proximal end of the forceps of FIG. 1A, wherein the movable handle is disposed in an depressed position, the trigger is disposed in a second actuated position, and a knife lock assembly is disposed in a locked configuration;

FIG. 5B is a side, cross-sectional view of the distal end of the forceps of FIG. 1A, wherein the jaw members of the end effector assembly are disposed in the approximated position corresponding to the depressed position of the movable handle and the knife is retained in a second extended position corresponding to the second actuated position of the trigger and the locked configuration of the knife lock assembly; and

FIG. 6 is a schematic illustration of a robotic surgical system configured for use in conjunction with aspects and features of the present disclosure.

DETAILED DESCRIPTION

[0021] Referring to FIGS. 1A and 1B, an electrosurgical forceps 10 for use in connection with endoscopic surgical procedures is shown, although forceps 10 may also be configured for use in connection with traditional open surgical procedures and/or with any suitable form of energy. Forceps 10 generally includes a housing 20, a handle assembly 30, a trigger assembly 60, a knife lock assembly 80, a rotating assembly 90, and an end effector assembly 100. End effector assembly 100 includes first and second jaw members 110, 120, respectively, at least one of which is configured to pivot relative to the other between a spaced-apart position (FIG. 2B) and an approximated position (FIG. 3B) for grasping tissue therebetween. Forceps 10 further includes a shaft 12 having a distal end 14 configured to engage end effector assembly 100 and a proximal end 16 that engages housing 20. Rotating assembly 90 is rotatable in either direction to rotate end effector assembly 100 relative to shaft 12 and housing 20 in either direction. Housing 20 houses the internal working components of forceps 10.

[0022] Forceps 10 also includes an electrosurgical cable 2 that connects forceps 10 to a generator (not shown) or other suitable power source, although forceps 10 may alternatively be configured as a battery powered instrument. Cable 2 includes a wire (or wires) 4 extending therethrough, into housing 20 and through shaft 12, to ultimately connect the source of energy to jaw member 110 and/or jaw member 120 of end effector assembly 100. An activation switch 6 mounted on housing 20 is electrically coupled between end effector assembly 100 and cable 2 so as to enable the selective supply of energy to jaw member 110 and/or jaw member 120, e.g., upon activation of activation switch 6. However, other suitable electrical connections and/or configurations for supplying energy to jaw member 110 and/or jaw member 120 may alternatively be provided.

[0023] End effector assembly 100 is attached at distal end 14 of shaft 12 and includes a pair of opposing jaw members 110 and 120. End effector assembly 100 is designed as a unilateral assembly, i.e., where jaw member 120 is fixed relative to shaft 12 and jaw member 110 is moveable relative to both shaft 12 and fixed jaw member 120. However, end effector assembly 100 may alternatively be configured as a bilateral assembly, i.e., where both jaw member 110 and jaw member 120 are moveable relative to one another and with respect to shaft 12. Each jaw member 110, 120 includes an electrically-conductive tissue-contacting surface 112, 122 disposed thereon. Surfaces 112, 122 are positioned on jaw members 110, 120, respectively, to oppose one another for grasping and treating tissue disposed between jaw members 110, 120.

[0024] With additional reference to FIGS. 2A-3B, handle assembly 30 includes a fixed handle 50 and a movable handle 40. Fixed handle 50 is integrally associated with housing 20 and movable handle 40 is moveable relative to fixed handle 50. Movable handle 40 is ultimately connected to a drive assembly 160 that, together, mechanically cooperate to impart movement of jaw members 110 and 120 between the spaced-apart and approximated positions to grasp tissue between surfaces 112, 122, respectively. More specifically, movable handle 40 includes a bifurcated flange portion 42 that is pivotably coupled within housing 20 via a pivot 44 and is operably coupled with drive bar 162 of drive assembly 160 via a drive mandrel 164 such that pivoting of movable handle 40 towards fixed handle 30 effects longitudinal translation of drive mandrel 164 and, thus, drive bar 162 through housing 20 and shaft 12. Drive bar 162 is slidably disposed within shaft 12 and is coupled to jaw member 110 at the distal end thereof such that, as drive bar 162 is translated proximally through shaft 12, jaw member 110 is pivoted relative to jaw member 120 from the spaced-apart position (FIG. 2B) towards the approximated position (FIG. 3B). On the other hand, when movable handle 40 is released or returned to its initial position relative to fixed handle 30, drive bar 162 is translated distally, thereby pivoting jaw member 110 relative to jaw member 120

from the approximated position (FIG. 3B) back towards the spaced-apart position (FIG. 2B). However, this configuration may be reversed, e.g., where proximal translation of drive bar 162 moves jaw members 110, 120 towards the spaced-apart position and distal translation of drive bar 162 moves jaw members 110, 120 towards the approximated position.

[0025] As shown in FIG. 2A, moveable handle 40 is initially spaced-apart from fixed handle 50 and, correspondingly, jaw members 110, 120 are disposed in the spaced-apart position (FIG. 2B). Moveable handle 40 is depressible from this initial position to a compressed position corresponding to the approximated position of jaw members 110, 120 (see FIGS. 3A and 3B). With tissue grasped between surfaces 112, 122 of jaw members 110, 120, respectively, electrosurgical energy may be conducted between surfaces 112, 122, e.g., upon actuation of activation switch 6, to treat tissue grasped between jaw members 110, 120.

[0026] Referring to FIGS. 1A, 1B, and 3A-5B, a knife assembly 180 is disposed within shaft 12 and a knife channel 115, 125 is defined within one or both of jaw members 110, 120, respectively, to permit reciprocation of a knife 184 therethrough for cutting tissue grasped between jaw members 110, 120. Trigger 62 of trigger assembly 60 is operably coupled to knife 184 to advance knife 184 between a retracted position (FIG. 3B), wherein knife 184 is disposed within shaft 12, a first extended position (FIG. 4B), wherein knife 184 extends through knife channels 115, 125 defined within jaw members 110, 120 (but does not extend distally beyond jaw members 110, 120) to cut tissue grasped therebetween, and a second extended position (FIG. 5B), wherein knife 184 extends distally from jaw members 110, 120 to enable use of knife 184 as a scalpel. Knife channels 115, 125 define open distal ends so as to permit extension of knife 184 to the second extended position (FIG. 5B), although other configurations are also contemplated, e.g., knife 184 may be configured to ramp below surface 122 of jaw member 120 and through an aperture defined within the distal end of jaw member 120 to permit extension of knife 184 to the second extended position (FIG. 5B).

[0027] Knife assembly 180 further includes a knife bar 182 that is slidably disposed within drive bar 162. Knife 184 is coupled to knife bar 182 at the proximal end of knife 184, while the distal end of knife 184 defines a cutting blade 186 configured to facilitate cutting of tissue. Trigger assembly 60 includes trigger 62 pivotably coupled to housing 20 and movable relative thereto between an un-actuated position (FIG. 3A), a first actuated position (FIG. 4A), and a second actuated position (FIG. 5A) for translating knife 184 between the retracted position (FIG. 3B), the first extended position (FIG. 4B), and the second extended position (FIG. 5B). More specifically, trigger 62 includes a manipulation portion 63 extending from housing 20 to enable actuation of trigger 62 by a user, a bifurcated flange portion 64 (only one leg of the bifurcated flange portion 64 is illustrated in FIGS. 2A, 3A,

4A, and 5A) to enable illustration of the components disposed therebetween) extending upwardly into housing 20, and an intermediate portion 65 disposed between manipulation portion 63 and bifurcated flange portion 64 and about which trigger 62 is pivotably coupled to housing 20. Each leg of bifurcated flange portion 64 defines a slot 66 therethrough. A pin 67 extends through slots 66 and between the legs of bifurcated flange portion 64. Pin 67 is engaged within an annular slot 73 defined within proximal mandrel 72 of slider 70. Slider 70 is slidably disposed about drive bar 162 and engaged with knife bar 182, e.g., via a pin (not shown) engaged with slider 70 and knife bar 182 and extending through a slot (not shown) defined within drive bar 162) such that pivoting of trigger 62 from the un-actuated position (FIG. 3A) to the first actuated position (FIG. 4A) urges bifurcated flange portion 64 distally, thereby urging proximal mandrel 72 and slider 70 distally and, thus, translating knife bar 182 distally through drive bar 162 and shaft 12 and relative to end effector assembly 100 to deploy knife 184. A biasing member 68 may be disposed within housing 20 and positioned to bias slider 70 proximally, thereby biasing knife 184 towards the retracted position (FIG. 3B) and trigger 62 towards the un-actuated position (FIG. 3A).

[0028] Continuing with reference to FIGS. 1A, 1B, and 3A-5B, knife lock assembly 80 includes a lock/unlock actuator 82 including a base 84 slidably disposed within housing 20 in generally vertical orientation (generally perpendicular to the longitudinally-extending shaft 12, drive bar 162, and knife bar 182) and an actuator button 86 disposed at an end of base 84 to facilitate actuation of lock/unlock actuator 82. As detailed below, lock/unlock actuator 82 is selectively actuatable to permit movement of trigger 62 from the un-actuated position (FIG. 3A) or the first actuated position (FIG. 4A) to the second actuated position (FIG. 5A), thus permitting extension of knife 184 from the retracted position (FIG. 3B) or the first extended position (FIG. 4B) to the second extended position (FIG. 5A).

[0029] Base 84 of lock/unlock actuator 82 of knife lock assembly 80 defines a vertical slot 88 therein so as to permit passage of drive bar 162 (and knife bar 182, which is disposed within drive bar 162) therethrough. Initially, in a locked position of actuator 82, vertical slot 88 is off-center relative to drive bar 162 such that at least a portion of base 84 inhibits the translation of slider 70 so as to inhibit actuation of trigger 62 beyond the first actuated position (FIG. 4A), thereby inhibiting extension of knife 184 beyond the first extended position (FIG. 4B). More specifically, base 84 interferes with distal mandrel 74 of slider 70 to inhibit further distal translation thereof beyond the first actuated position of trigger 62 (FIG. 4A) and the first extended position of knife 184 (FIG. 4B). A biasing member 89 disposed within housing 20 and connected between housing 20 and the free end of base 84 biases base 84 downwardly corresponding to the off-center positioning of vertical slot 88, e.g., the locked position of actuator 82.

[0030] Lock/unlock actuator 82 of knife lock assembly 80 is movable, e.g., via depression of actuator button 86 towards housing 20, against the bias of biasing member 89 from the locked position (FIGS. 3A, 4A, and 5A) to an unlocked position, wherein vertical slot 88 is centered relative to drive bar 162. In this centered position of vertical slot 88, distal mandrel 74 of slider 70 is capable of extending at least partially through vertical slot 88, sufficiently so as to permit movement of trigger 62 from the un-actuated position (FIG. 3A) or the first actuated position (FIG. 4A) to the second actuated position (FIG. 5A), thus permitting extension of knife 184 from the retracted position (FIG. 3B) or the first extended position (FIG. 4B) to the second extended position (FIG. 5B). As noted above, actuation of trigger 62 to the second actuated position (FIG. 5A) moves knife 184 to the second extended position (FIG. 5B). In this position, slider 70 is positioned such that annular slot 76 defined within distal mandrel 74 is disposed within slot 88 of base 84 of lock/unlock actuator 82. Thus, upon release of lock/unlock actuator 82, biasing member 89 urges lock/unlock actuator 82 to return to the locked position, wherein vertical slot 88 is moved to the off-center position relative to drive bar 162. With annular slot 76 of distal mandrel 74 of slider 70 disposed within slot 88 of base 84, such return of lock/unlock actuator 82 to the locked position retains slider 70 in position corresponding to the second actuated position of trigger 62 (FIG. 5A) and the second extended position of knife 184 (FIG. 5B) due to interference between distal mandrel 74 on either side of base 84 (which is received within annular slot 76 of distal mandrel 74). Accordingly, with knife 184 locked in the second extended position (FIG. 5B), knife 184 may be utilized as a scalpel, for example, to cut through tissue layers to reach tissue to be treated.

[0031] In order to release knife 184 from the second extended position (FIG. 5B), lock/unlock actuator 82 is once again depressed towards housing 20 to the unlocked position, wherein vertical slot 88 is centered relative to drive bar 162. In this centered position of vertical slot 88, similarly as detailed above, sufficient clearance is provided so as to enable distal mandrel 74 and, thus, slider 70 to return proximally relative to lock/unlock actuator 82 to the un-actuated position (FIG. 3A) or first actuated position (FIG. 4A). Once the un-actuated position (FIG. 3A) or first actuated position (FIG. 4A) has been achieved, lock/unlock actuator 82 may be released, allowing lock/unlock actuator 82 to return to its biased, locked position. With lock/unlock actuator 82 returned to the locked position, trigger 62 is once again confined to movement between the un-actuated position (FIG. 3A) and the first actuated position (FIG. 4A) and, accordingly, knife 184 is confined to movement between the retracted position (FIG. 3B) and the first extended position (FIG. 4B).

[0032] The various embodiments disclosed herein may also be configured to work with robotic surgical systems and what is commonly referred to as "Telesurgery."

Such systems employ various robotic elements to assist the surgeon and allow remote operation (or partial remote operation) of surgical instrumentation. Various robotic arms, gears, cams, pulleys, electric and mechanical motors, etc. may be employed for this purpose and may be designed with a robotic surgical system to assist the surgeon during the course of an operation or treatment. Such robotic systems may include remotely steerable systems, automatically flexible surgical systems, remotely flexible surgical systems, remotely articulating surgical systems, wireless surgical systems, modular or selectively configurable remotely operated surgical systems, etc.

[0033] The robotic surgical systems may be employed with one or more consoles that are next to the operating theater or located in a remote location. In this instance, one team of surgeons or nurses may prep the patient for surgery and configure the robotic surgical system with one or more of the instruments disclosed herein while another surgeon (or group of surgeons) remotely control the instruments via the robotic surgical system. As can be appreciated, a highly skilled surgeon may perform multiple operations in multiple locations without leaving his/her remote console which can be both economically advantageous and a benefit to the patient or a series of patients.

[0034] The robotic arms of the surgical system are typically coupled to a pair of master handles by a controller. The handles can be moved by the surgeon to produce a corresponding movement of the working ends of any type of surgical instrument (e.g., end effectors, graspers, knives, scissors, etc.) which may complement the use of one or more of the embodiments described herein. The movement of the master handles may be scaled so that the working ends have a corresponding movement that is different, smaller or larger, than the movement performed by the operating hands of the surgeon. The scale factor or gearing ratio may be adjustable so that the operator can control the resolution of the working ends of the surgical instrument(s).

[0035] The master handles may include various sensors to provide feedback to the surgeon relating to various tissue parameters or conditions, e.g., tissue resistance due to manipulation, cutting or otherwise treating, pressure by the instrument onto the tissue, tissue temperature, tissue impedance, etc. As can be appreciated, such sensors provide the surgeon with enhanced tactile feedback simulating actual operating conditions. The master handles may also include a variety of different actuators for delicate tissue manipulation or treatment further enhancing the surgeon's ability to mimic actual operating conditions.

[0036] Referring to FIG. 6, a medical work station is shown generally as work station 1000 and generally may include a plurality of robot arms 1002, 1003; a control device 1004; and an operating console 1005 coupled with control device 1004. Operating console 1005 may include a display device 1006, which may be set up in par-

ticular to display three-dimensional images; and manual input devices 1007, 1008, by means of which a person (not shown), for example a surgeon, may be able to tele-manipulate robot arms 1002, 1003 in a first operating mode.

[0037] Each of the robot arms 1002, 1003 may include a plurality of members, which are connected through joints, and an attaching device 1009, 1011, to which may be attached, for example, a surgical tool "ST" supporting an end effector 1100, in accordance with any one of several embodiments disclosed herein, as will be described in greater detail below.

[0038] Robot arms 1002, 1003 may be driven by electric drives (not shown) that are connected to control device 1004. Control device 1004 (e.g., a computer) may be set up to activate the drives, in particular by means of a computer program, in such a way that robot arms 1002, 1003, their attaching devices 1009, 1011 and thus the surgical tool (including end effector 1100) execute a desired movement according to a movement defined by means of manual input devices 1007, 1008. Control device 1004 may also be set up in such a way that it regulates the movement of robot arms 1002, 1003 and/or of the drives.

[0039] Medical work station 1000 may be configured for use on a patient 1013 lying on a patient table 1012 to be treated in a minimally invasive manner by means of end effector 1100. Medical work station 1000 may also include more than two robot arms 1002, 1003, the additional robot arms likewise being connected to control device 1004 and being telemanipulatable by means of operating console 1005. A medical instrument or surgical tool (including an end effector 1100) may also be attached to the additional robot arm. Medical work station 1000 may include a database 1014, in particular coupled to with control device 1004, in which are stored, for example, preoperative data from patient/living being 1013 and/or anatomical atlases.

[0040] From the foregoing and with reference to the various figure drawings, those skilled in the art will appreciate that certain modifications can also be made to the present disclosure without departing from the scope of the same. While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

[0041] The invention may be described by reference to the following numbered paragraphs:-

1. A surgical forceps, comprising:

a housing;

a shaft extending distally from the housing;
an end effector assembly disposed at a distal end of the shaft and including first and second jaw members configured for grasping tissue therebetween;

a knife assembly disposed within the shaft and including a knife bar having a knife disposed at a distal end thereof, the knife bar longitudinally translatable through the shaft and relative to the end effector assembly to translate the knife between a retracted position, wherein the knife is disposed proximally of the end effector assembly, a first extended position, wherein the knife extends between the first and second jaw members, and a second extended position, wherein the knife extends distally from the first and second jaw members;

a trigger assembly associated with the housing and including a trigger operably coupled with the knife bar such that movement of the trigger between an un-actuated position, a first actuated position, and a second actuated position moves the knife between the retracted position, the first extended position, and the second extended position, respectively; and

a knife lock assembly associated with the housing, the knife lock assembly including an actuator movable between a locked position and an unlocked position and configured to selectively permit movement of the knife between the retracted position or first extended position and the second extended position.

2. The forceps according to paragraph 1, wherein the trigger assembly includes a slider coupled between the trigger and the knife bar, wherein, with the trigger disposed in the un-actuated position or the first actuated position and the actuator disposed in the locked position, the actuator interferes with the slider to inhibit movement of the trigger to the second actuated position, wherein, with the trigger disposed in the second actuated position and the actuator disposed in the locked position, the actuator engages the slider to inhibit movement of the slider, thereby retaining the trigger in the second actuated position, and wherein, with actuator disposed in the unlocked position, the actuator permits translation of the slider therethrough such that the trigger is movable between the un-actuated position or the first actuated position and the second actuated position.

3. The forceps according to paragraph 2, wherein the slider includes a proximal mandrel operably coupling the trigger with the knife bar and a distal mandrel operably associated with the actuator.

4. The forceps according to paragraph 1, wherein the actuator is biased towards the locked position.

5. The forceps according to paragraph 1, wherein

the actuator includes an actuator button disposed on the housing, the actuator button selectively depressible relative to the housing to move the actuator from the locked position to the unlocked position.

6. The forceps according to paragraph 1, further including:

a drive assembly including a drive bar slidably disposed within the shaft, the drive bar coupled to at least one of the first and second jaw members at a distal end thereof; and
a handle assembly associated with the housing and including a movable handle operably coupled with the drive bar, the movable handle movable between an initial position and a compressed position for moving the first and second jaw members from a spaced-apart position to an approximated position for grasping tissue therebetween.

7. The forceps according to paragraph 1, wherein each of the first and second jaw members includes an electrically-conductive surface adapted to connect to a source of energy for treating tissue grasped between the first and second jaw members.

8. The forceps according to paragraph 1, wherein each of the first and second jaw members defines a knife slot configured to permit reciprocation of the knife therethrough.

9. A surgical forceps, comprising:

a housing;
a shaft extending distally from the housing;
an end effector assembly disposed at a distal end of the shaft and including first and second jaw members configured for grasping tissue therebetween;
a knife assembly disposed within the shaft and including a knife bar having a knife disposed at a distal end thereof, the knife bar longitudinally translatable through the shaft and relative to the end effector assembly to translate the knife between a retracted position, wherein the knife is disposed proximally of the end effector assembly, a first extended position, wherein the knife extends between the first and second jaw members, and a second extended position, wherein the knife extends distally from the first and second jaw members;
a slider operably coupled to the knife bar;
a trigger assembly associated with the housing and including a trigger operably coupled with the slider such that movement of the trigger between an un-actuated position, a first actuated position, and a second actuated position moves the knife between the retracted position, the first extended position, and the second extended position, respectively; and

a knife lock assembly associated with the housing, the knife lock assembly including an actuator movable between a locked position and an unlocked position, wherein, in the locked position, the actuator interferes with the slider to inhibit movement of the trigger from the un-actuated position or the first actuated position to the second actuated position, and wherein, in the unlocked position, the actuator permits movement of the trigger between the un-actuated position or the first actuated position and the second actuated position.

10. The forceps according to paragraph 9, wherein the slider includes a proximal mandrel operably coupling the trigger with the knife bar and a distal mandrel operably associated with the actuator.

11. The forceps according to paragraph 9, wherein the actuator is biased towards the locked position.

12. The forceps according to paragraph 9, wherein the actuator includes an actuator button disposed on the housing, the actuator button selectively depressible relative to the housing to move the actuator from the locked position to the unlocked position.

13. The forceps according to paragraph 9, further including:

a drive assembly including a drive bar slidably disposed within the shaft, the drive bar coupled to at least one of the first and second jaw members at a distal end thereof; and
a handle assembly associated with the housing and including a movable handle operably coupled with the drive bar, the movable handle movable between an initial position and a compressed position for moving the first and second jaw members from a spaced-apart position to an approximated position for grasping tissue therebetween.

14. The forceps according to paragraph 9, wherein each of the first and second jaw members includes an electrically-conductive surface adapted to connect to a source of energy for treating tissue grasped between the first and second jaw members.

15. The forceps according to paragraph 9, wherein each of the first and second jaw members defines a knife slot configured to permit reciprocation of the knife therethrough.

Claims

1. A surgical forceps, comprising:

a housing;
a shaft extending distally from the housing;
an end effector assembly disposed at a distal

- end of the shaft and including first and second jaw members configured for grasping tissue therebetween;
 a knife assembly disposed within the shaft and including a knife bar having a knife disposed at a distal end thereof, the knife bar longitudinally translatable through the shaft and relative to the end effector assembly to translate the knife between a retracted position, wherein the knife is disposed proximally of the end effector assembly, a first extended position, wherein the knife extends between the first and second jaw members, and a second extended position, wherein the knife extends distally from the first and second jaw members;
 a trigger assembly associated with the housing and including a trigger operably coupled with the knife bar such that movement of the trigger between an un-actuated position, a first actuated position, and a second actuated position moves the knife between the retracted position, the first extended position, and the second extended position, respectively; and
 a knife lock assembly associated with the housing, the knife lock assembly including an actuator movable between a locked position and an unlocked position and configured to selectively permit movement of the knife between the retracted position or first extended position and the second extended position.
2. The forceps according to claim 1, wherein the trigger assembly includes a slider coupled between the trigger and the knife bar, wherein, with the trigger disposed in the un-actuated position or the first actuated position and the actuator disposed in the locked position, the actuator interferes with the slider to inhibit movement of the trigger to the second actuated position, wherein, with the trigger disposed in the second actuated position and the actuator disposed in the locked position, the actuator engages the slider to inhibit movement of the slider, thereby retaining the trigger in the second actuated position, and wherein, with actuator disposed in the unlocked position, the actuator permits translation of the slider therethrough such that the trigger is movable between the un-actuated position or the first actuated position and the second actuated position.
3. The forceps according to claim 2, wherein the slider includes a proximal mandrel operably coupling the trigger with the knife bar and a distal mandrel operably associated with the actuator.
4. The forceps according to claim 1, 2 or 3, wherein the actuator is biased towards the locked position.
5. The forceps according to any preceding claim, wherein the actuator includes an actuator button disposed on the housing, the actuator button selectively depressible relative to the housing to move the actuator from the locked position to the unlocked position.
6. The forceps according to any preceding claim, further including:
 a drive assembly including a drive bar slidably disposed within the shaft, the drive bar coupled to at least one of the first and second jaw members at a distal end thereof; and
 a handle assembly associated with the housing and including a movable handle operably coupled with the drive bar, the movable handle movable between an initial position and a compressed position for moving the first and second jaw members from a spaced-apart position to an approximated position for grasping tissue therebetween.
7. The forceps according to any preceding claim, wherein each of the first and second jaw members includes an electrically-conductive surface adapted to connect to a source of energy for treating tissue grasped between the first and second jaw members.
8. The forceps according to any preceding claim, wherein each of the first and second jaw members defines a knife slot configured to permit reciprocation of the knife therethrough.
9. A surgical forceps, comprising:
 a housing;
 a shaft extending distally from the housing;
 an end effector assembly disposed at a distal end of the shaft and including first and second jaw members configured for grasping tissue therebetween;
 a knife assembly disposed within the shaft and including a knife bar having a knife disposed at a distal end thereof, the knife bar longitudinally translatable through the shaft and relative to the end effector assembly to translate the knife between a retracted position, wherein the knife is disposed proximally of the end effector assembly, a first extended position, wherein the knife extends between the first and second jaw members, and a second extended position, wherein the knife extends distally from the first and second jaw members;
 a slider operably coupled to the knife bar;
 a trigger assembly associated with the housing and including a trigger operably coupled with the slider such that movement of the trigger between

an un-actuated position, a first actuated position, and a second actuated position moves the knife between the retracted position, the first extended position, and the second extended position, respectively; and

of the knife therethrough.

a knife lock assembly associated with the housing, the knife lock assembly including an actuator movable between a locked position and an unlocked position, wherein, in the locked position, the actuator interferes with the slider to inhibit movement of the trigger from the un-actuated position or the first actuated position to the second actuated position, and wherein, in the unlocked position, the actuator permits movement of the trigger between the un-actuated position or the first actuated position and the second actuated position.

10. The forceps according to claim 9, wherein the slider includes a proximal mandrel operably coupling the trigger with the knife bar and a distal mandrel operably associated with the actuator.
11. The forceps according to claim 9 or 10, wherein the actuator is biased towards the locked position.
12. The forceps according to any of claims 9 to 11, wherein the actuator includes an actuator button disposed on the housing, the actuator button selectively depressible relative to the housing to move the actuator from the locked position to the unlocked position.
13. The forceps according to any of claims 9 to 12, further including:
 - a drive assembly including a drive bar slidably disposed within the shaft, the drive bar coupled to at least one of the first and second jaw members at a distal end thereof; and
 - a handle assembly associated with the housing and including a movable handle operably coupled with the drive bar, the movable handle movable between an initial position and a compressed position for moving the first and second jaw members from a spaced-apart position to an approximated position for grasping tissue therebetween.
14. The forceps according to any of claims 9 to 13, wherein each of the first and second jaw members includes an electrically-conductive surface adapted to connect to a source of energy for treating tissue grasped between the first and second jaw members.
15. The forceps according to any one of claims 9 to 14, wherein each of the first and second jaw members defines a knife slot configured to permit reciprocation

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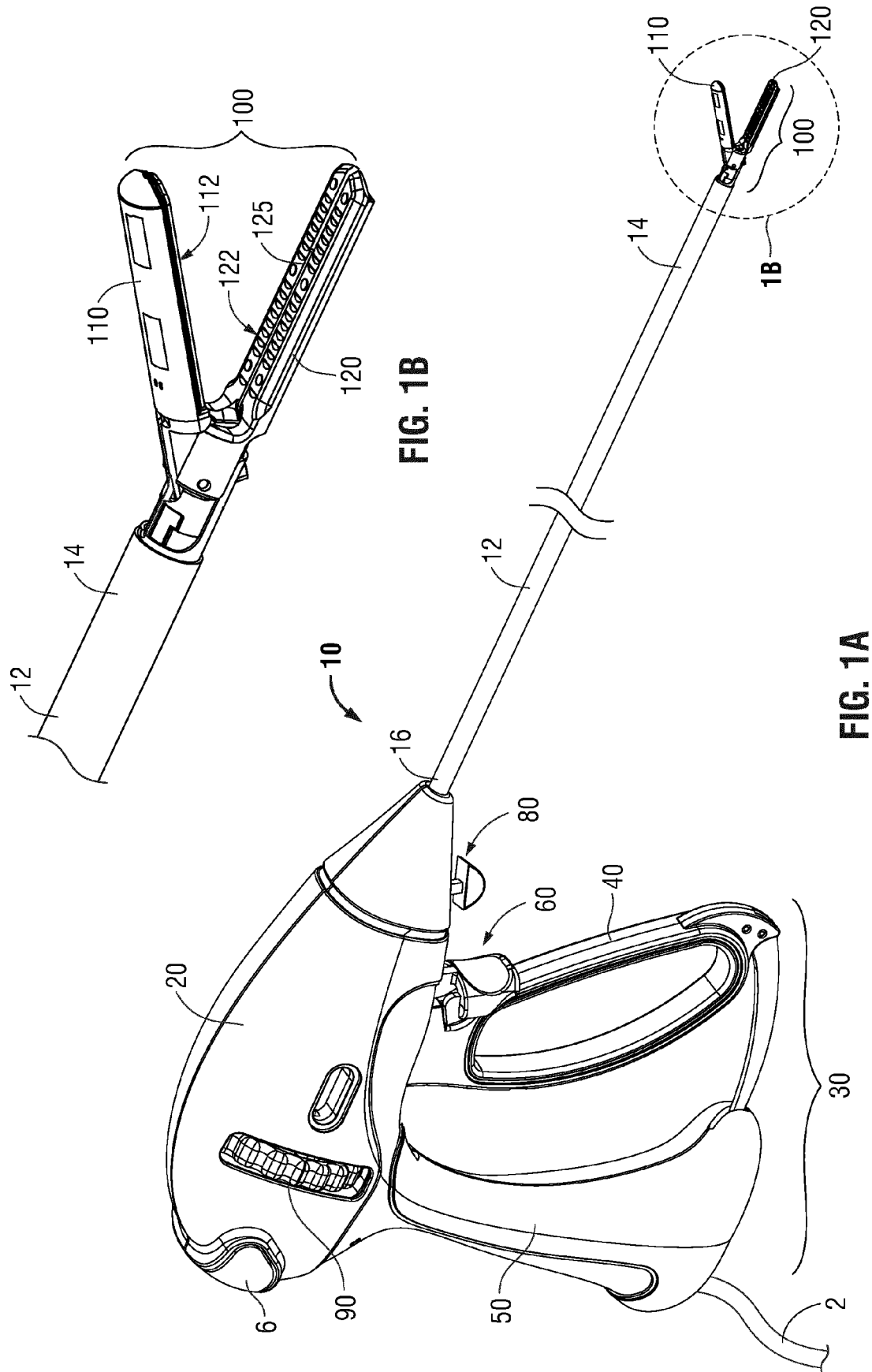
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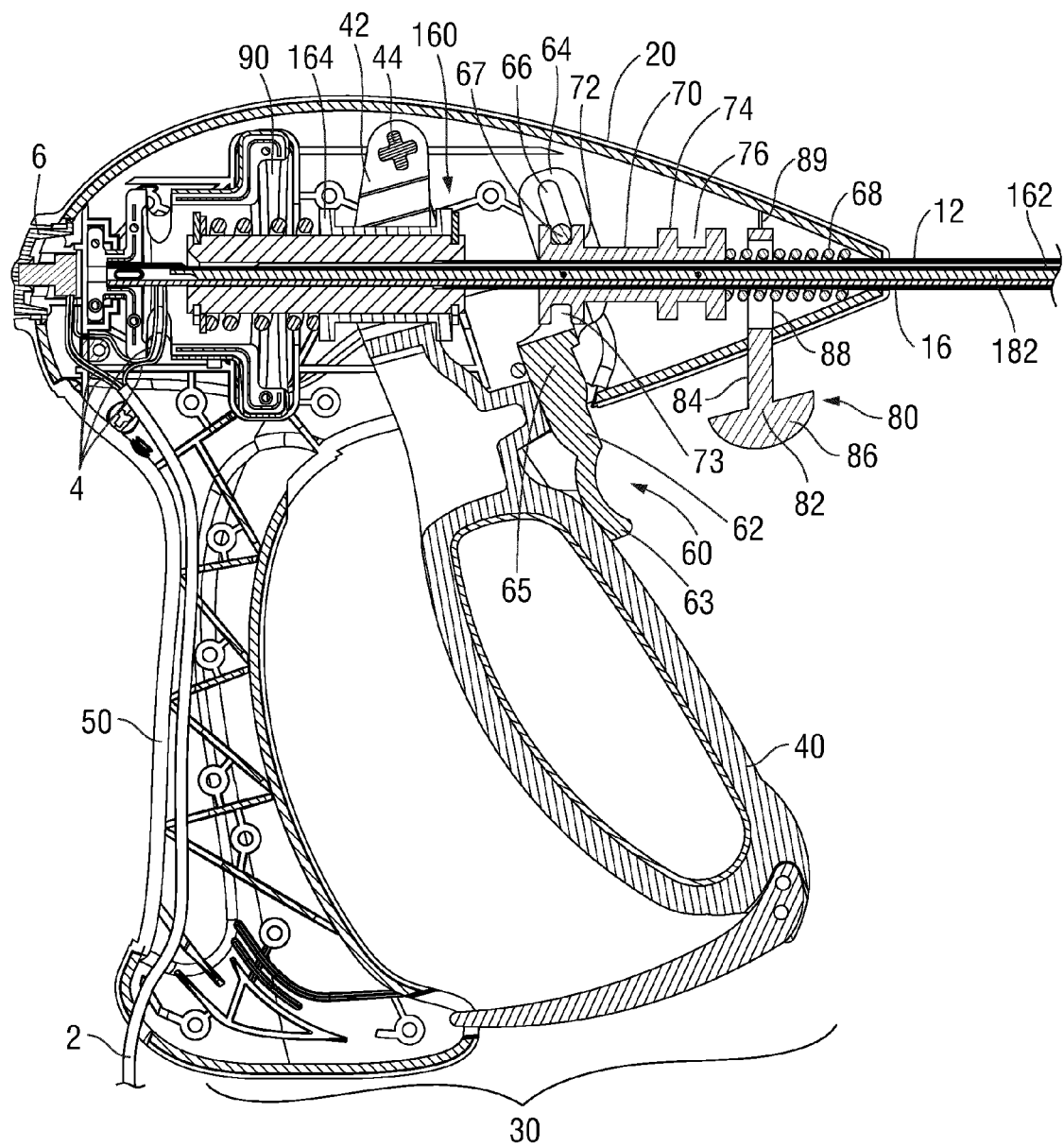


FIG. 2A

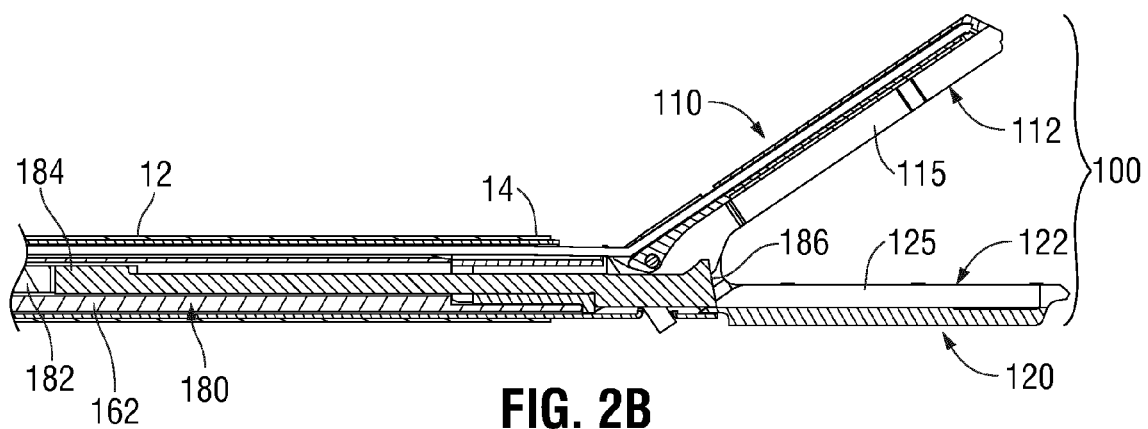


FIG. 2B

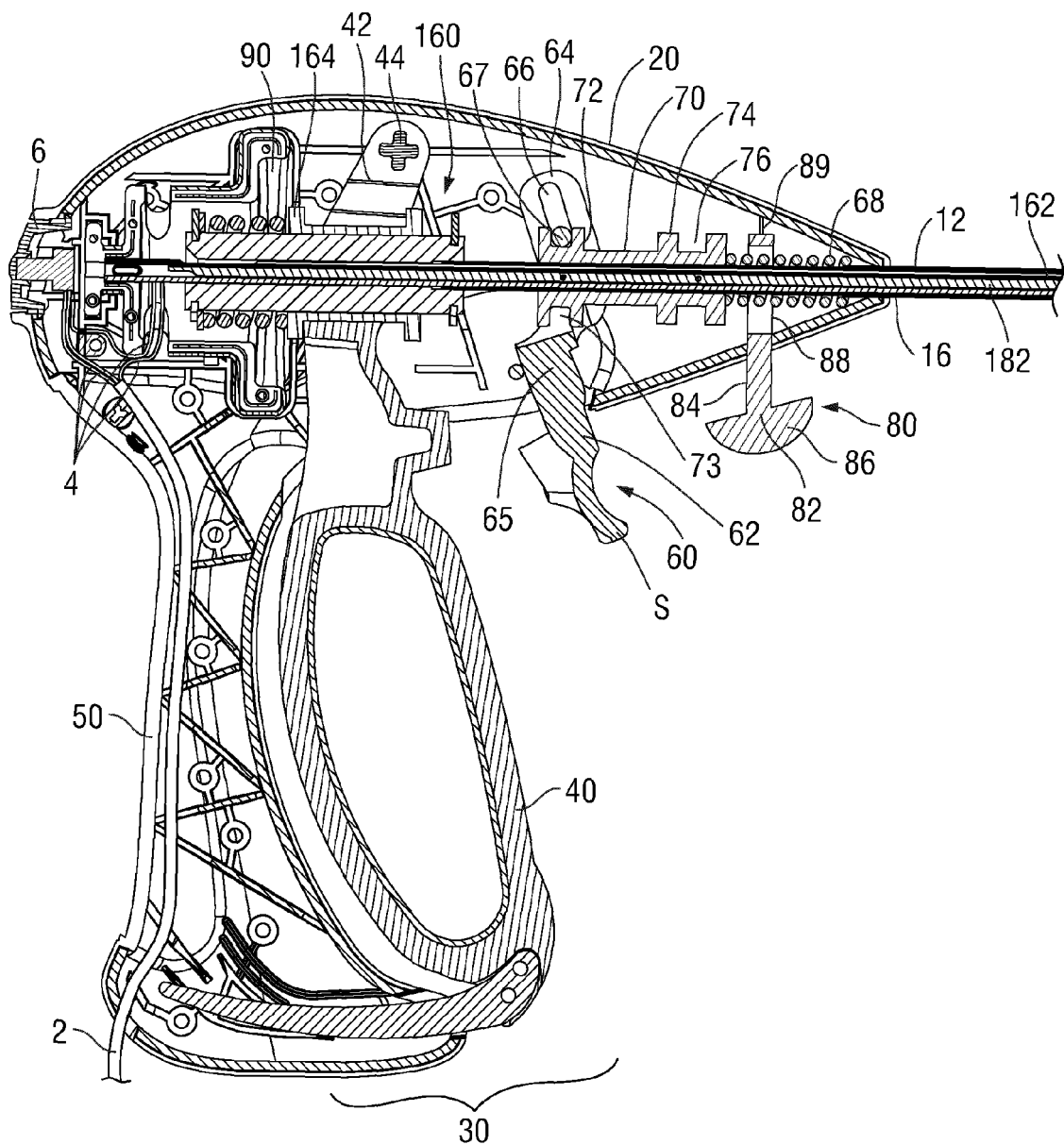


FIG. 3A

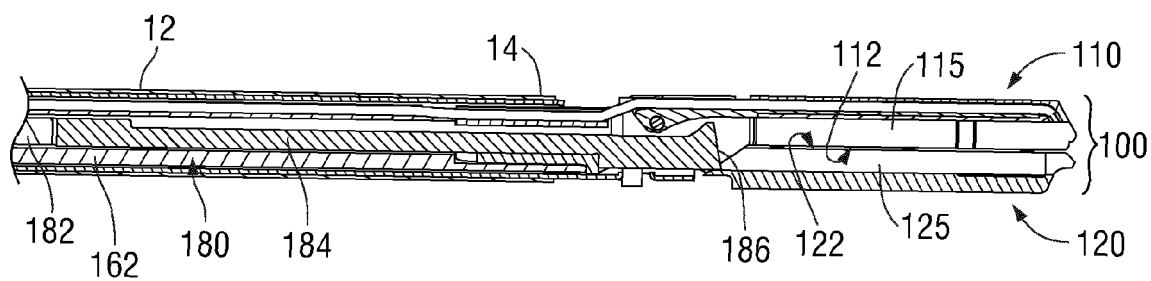


FIG. 3B

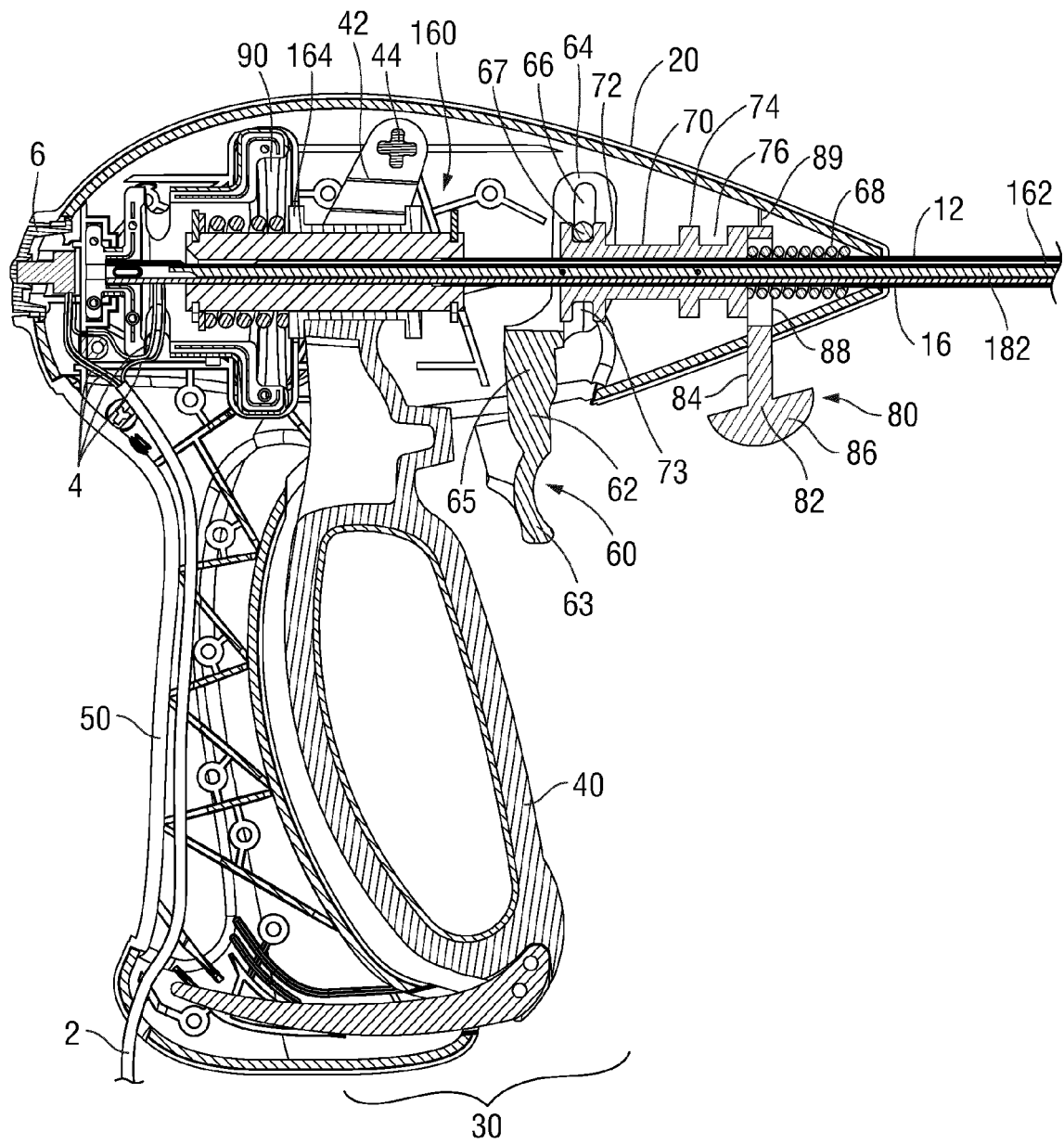


FIG. 4A

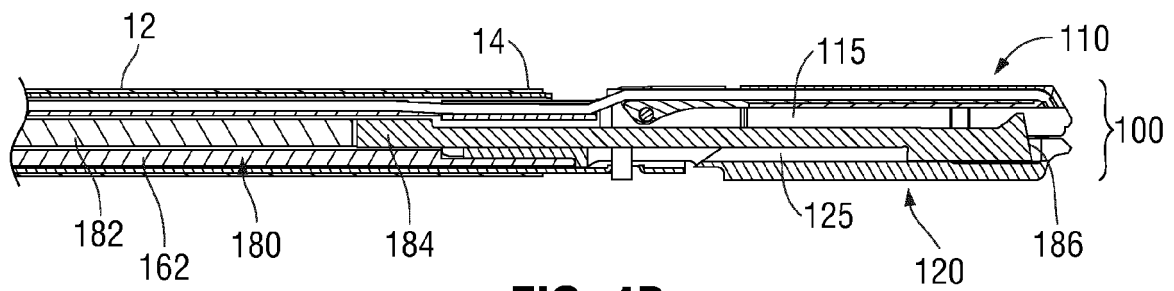


FIG. 4B

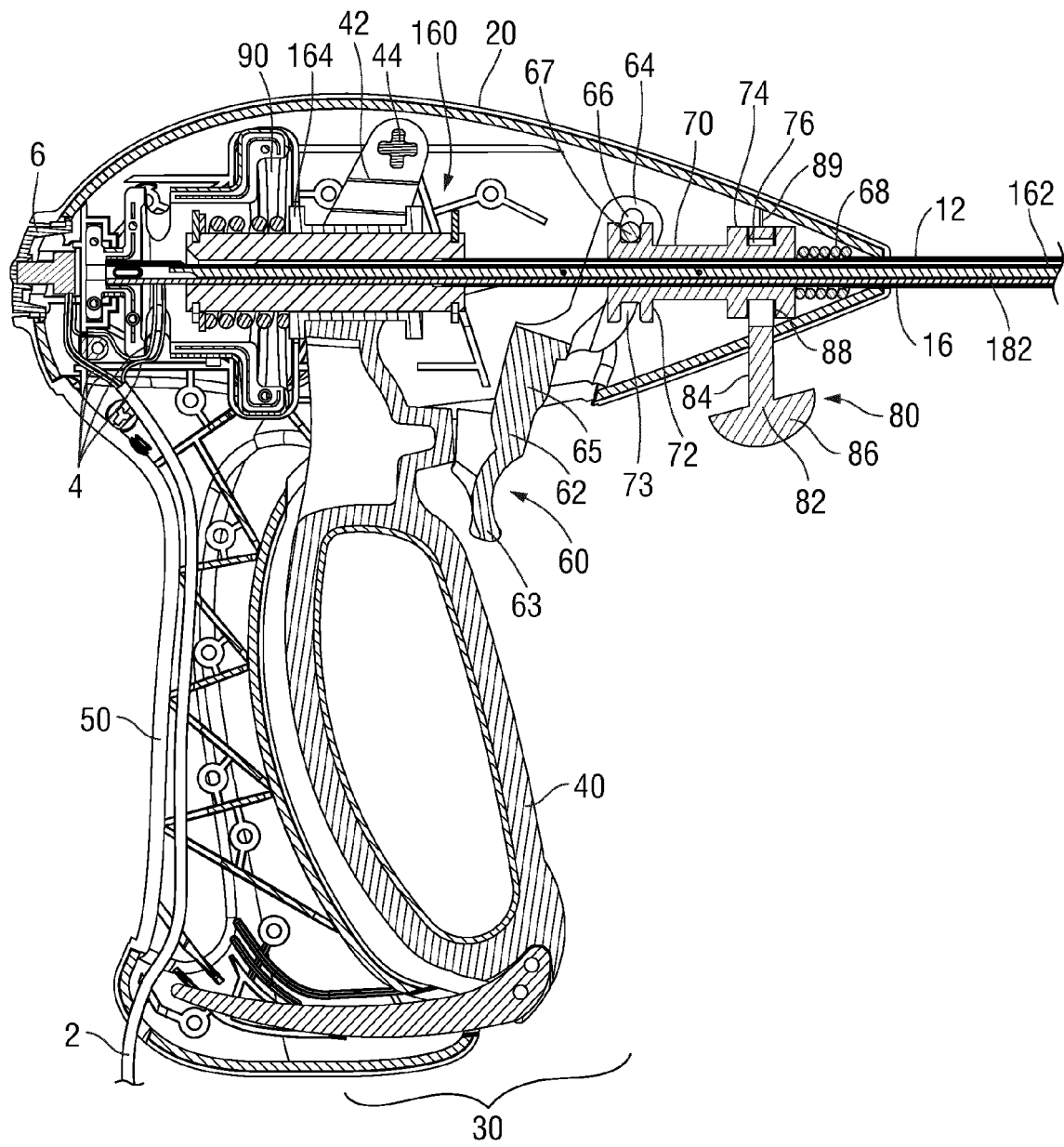


FIG. 5A

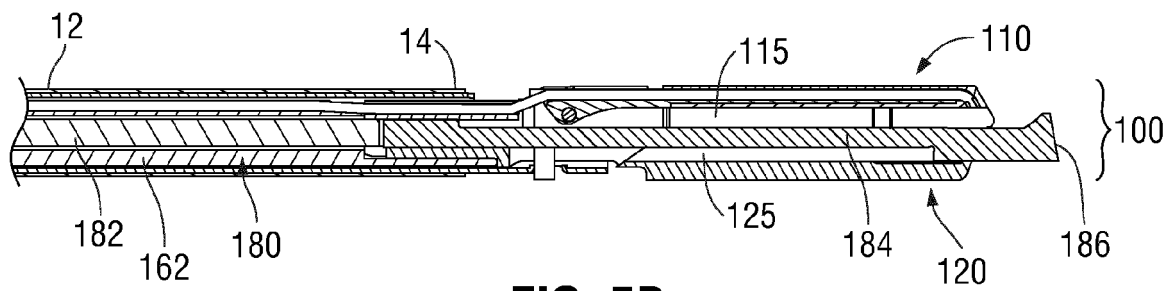


FIG. 5B

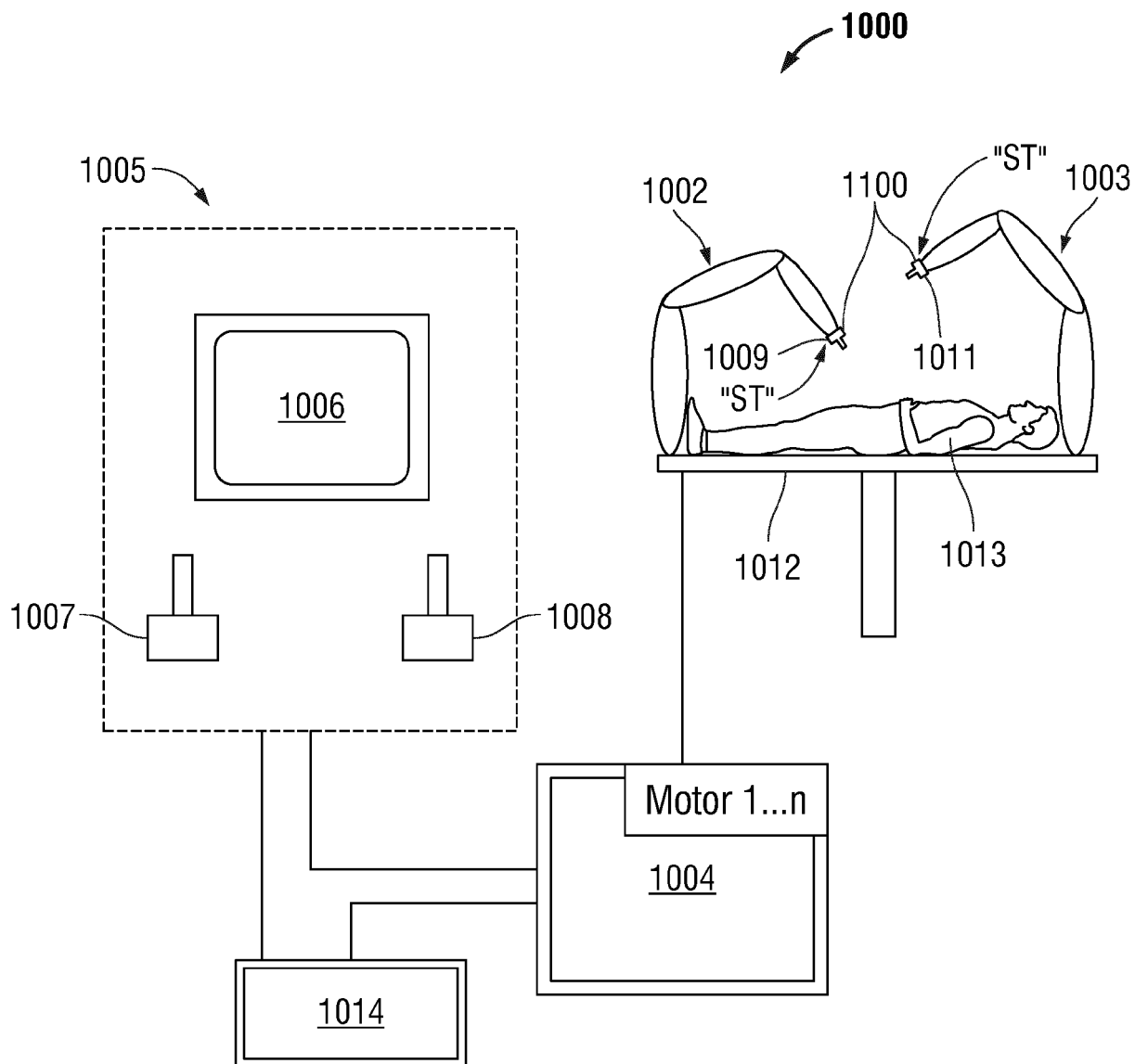


FIG. 6



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Application Number
EP 16 15 9789

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Place of search The Hague		Date of completion of the search 18 August 2016	Examiner Schmidt, Matthias
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